May 26, 1970 M. MINTZ 3,513,668

TUBULAR KNIT FABRIC

Filed Feb. 10, 1967 3 Sheets-Sheet 1

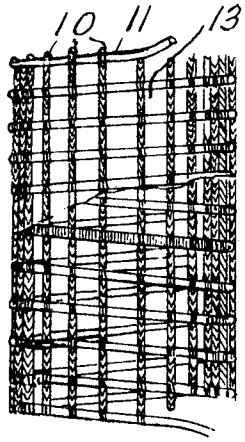

FIG. 1

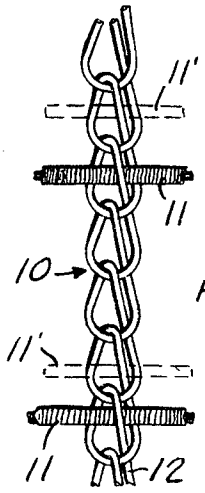

FIG. 3

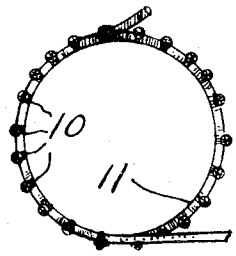

FIG. 2

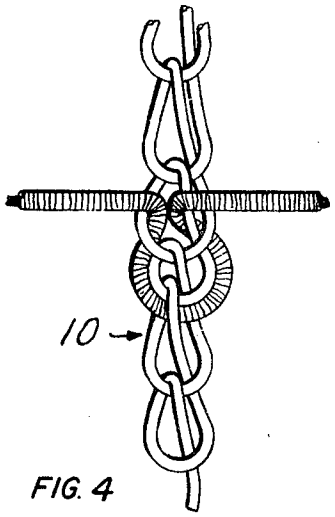

FIG. 4

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FIG. 5

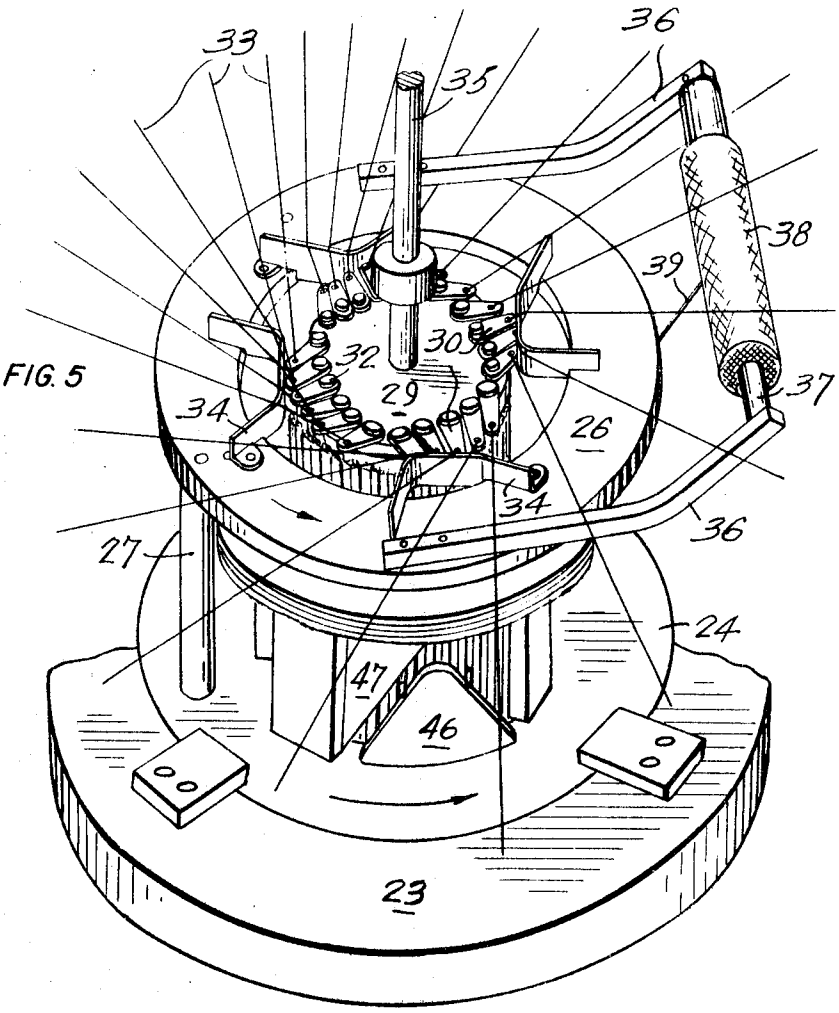

FIG. 6

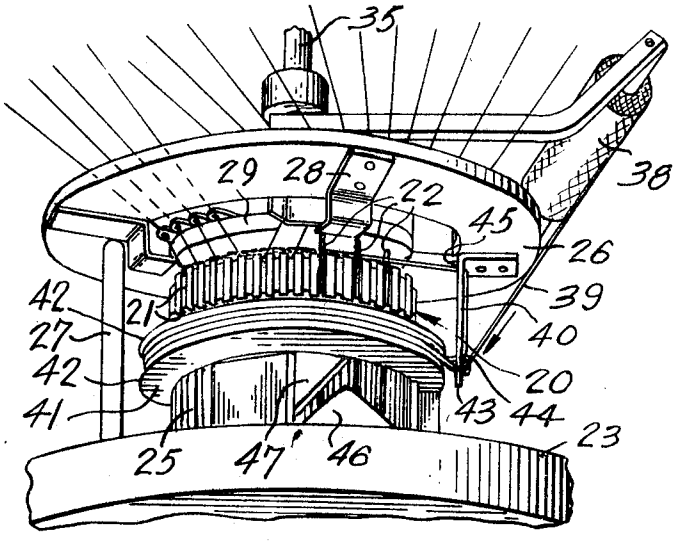

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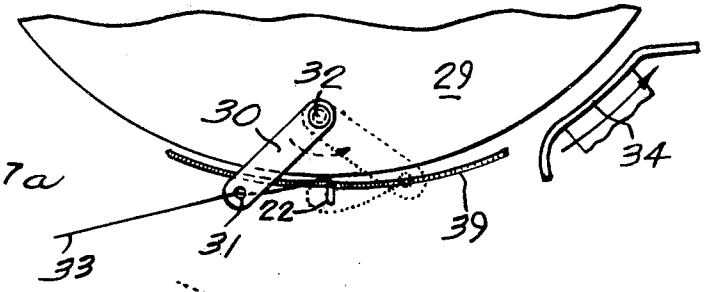
FIG. 7a



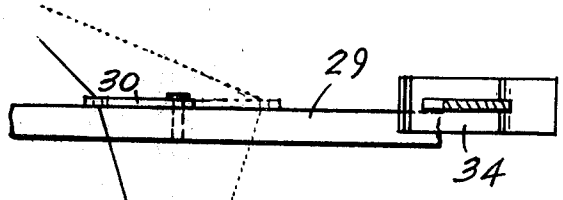


FIG. 7b

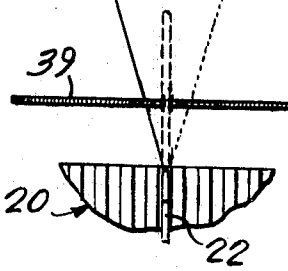
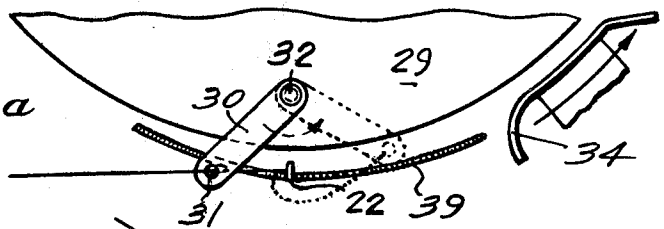


FIG. 8a



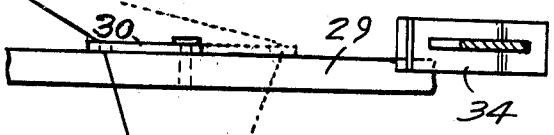
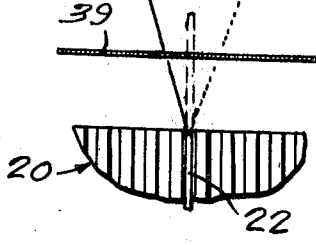


FIG. 8b



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United States Patent Office 3,513,668 Patented May 26, 1970

3,513,668

TUBULAR KNIT FABRIC

Marcus Mintz, Chomedey, Quebec, Canada, assignor to Industrial Knitting, Inc., Montreal, Quebec, Canada

Filed Feb. 10, 1967, Ser. No. 615,201
Int. Cl. D04b 21/12
U.S. Cl. 66—193 1 Claim

ABSTRACT OF THE DISCLOSURE

A net fabric made up of warp wales interengaged by one or more spiral weft ends. Preferably, the weft end is elastic. A circular knitting machine having individually pivotable warp yarn guides operated by cams for effecting warp knitting. A tensioning device for feeding the elastic weft and consisting of a wheel stationary relative to the frame and around which the elastic is wrapped at full stretch and subsequently unwound at a reduced tension.

The present invention relates to improvements in tubular knitting and embraces a novel method of knitting, novel knitting apparatus, and a particular novel form of net fabric which may be produced by the aforesaid method and apparatus.

Known kitting systems fall generally into two types, warp knitting and weft knitting, and at the same time, kniting machines generally fall into two different types, namely flat knitting machines and circular or cylindrical knitting machines. While flat knitting machines may be adapted for warp knitting or weft knitting, tubular knitting machines are generally confined to weft knitting since they are intrinsically less adaptable. The present invention is directed to enabling a tubular fabric to be produced by a combination of warp and weft knitting on a novel circular knitting machine. The machine is essentially simple and versatile and will enable known types of fabric to be produced as well as the novel type of fabric to be described. However, the preferred machine has a particular advantage in enabling the production of a novel type of elastic net fabric as will become apparent.

More particularly, in accordance with one form of the invention, there is provided a tubular knitted fabric comprising parallel spaced longitudinal warp wales crochet knit from separate ends and one or more weft ends each extending in a continuous spiral and in engagement with the warp wales, at least some of the loops being free from interengaged weft ends.

The weft end or ends may be laid through the loops of the warp wales, or alternatively, they may be knitted to at least some of the warp ends. The weft end or ends may comprise elastic yarn and a preferred fabric comprises parallel spaced longitudinal warp wales of substantially non-elastic yarn and continuously crochet knitted from separate warp ends, and one or more weft ends of elastic thread each extending in a continuous spiral and in engagement with the warp wales, the fabric comprising net openings defined by groups of successive wale loops free from interengaged weft ends.

In accordance with a second aspect of the invention, there is provided a method of tubular knitting a net or lacework fabric comprising knitting warp wales downwardly upon a horizontal circular knitting frame having vertically reciprocating needles and continuously interengaging selected loops of the warp wales as they are formed with one or more weft ends fed circumferentially, unselected loops being free from weft courses so as to provide openings.

In accordance with a third aspect of the invention, there is provided apparatus for tubular knitting comprising:

A cylindrical knitting frame having circumferentially distributed grooves containing vertically reciprocable hooked needles,

A first cam ring,

One or more first cams on the first cam ring arranged to raise and lower the needles successively for knitting,

A first support,

A plurality of pivotable warp thread guides mounted on said first support, each guide having a guiding portion movable in an arc across a respective needle selected as a warp needle from one side to the other for guiding a warp end to engagement in the hook of the warp needle,

Means for successively and continuously moving said pivotable guides relatively to said first support from one side of the respective needles to the other as the respective needles rises clear of its groove,

Means for successively and continuously returning the guides to the said one side,

Means for guiding one or more additional threads to interengage the warp wales as they are knitted, and

Means enabling relative rotation between said frame and said first support on the one hand and said first cam ring and additional thread guiding means on the other hand, and for enabling actuation of the warp guide moving means, for knitting.

Preferably, the apparatus includes means for guiding a weft end continuously into position adjacent successive warp needles to engage the end in the warp loops as they are formed in continuous wales and means enabling relative rotation between said frame and said support on the one hand and said first cam ring and weft guiding means on the other hand and for enabling actuation of the warp guide moving means, for knitting.

A preferred form of the apparatus includes a second rotatable cam ring located above said first cam ring and arranged for relative rotation together with said first cam ring,

A respective second cam on said second cam ring for each first cam, the second cams being positioned to engage said guides to move successive guides from said one side to said other side,

The apparatus further including means for resiliently constraining said guides towards said one side for returning the guides after release from said second cam.

Having thus generally described the invention, it will hereafter be described in greater detail with reference to the accompanying drawings which show and illustrate embodiments of fabric and apparatus and illustrate the preferred method of knitting. In the drawings:

FIG. 1 is a side view of a tubular knitted elastic net fabric in accordance with the invention, the upper part of the figure showing only the near side of the fabric for the sake of clarity;

FIG. 2 is a cross-sectional view of the fabric of FIG. 1;

FIG. 3 is a greatly magnified view of a portion of FIG. 1;

FIG. 4 is a view similar to FIG. 3 illustrating the form of knitting in a modification of the fabric in accordance with the invention;

FIG. 5 is a downward perspective view of an embodiment of knitting machine in accordance with the invention;

FIG. 6 is an upward perspective view of the machine of FIG. 5;

FIGS. 7*a* and 7*b* are diagrammatic views respectively in plan and side elevation illustrating the movement of the needle and warp and weft ends and pivotable yarn guides in the production of a fabric of the type of FIG. 3; and

FIGS. 8*a* and 8*b* are views corresponding to FIGS. 7*a* and 7*b* illustrating the form of knitting shown in FIG. 4.

THE FABRIC

With reference to FIGS. 1 to 3, there is shown a portion of a continuous tubular net fabric made up of parallel spaced, circumferentially distributed, and longitudinally extending warp wales **10** of continuous crochet knit, the stitch being best viewed in FIG. 3, each wale **10** being knitted from a separate end. The word "end" is used herein to express a separate piece of, for example, thread or yarn to distinguish from a course, wale or chain, several of which may be produced from a single end. The word "wale" is used to denote a column of loops extending the length of the fabric.

In the embodiments illustrated, a single weft end **11** is shown extending in a continuous spiral around and along the fabric in engagement with the warp wales. Due to the spiral convolutions, the weft end **11** forms a plurality of spaced courses and, as shown in FIG. 3, the courses are separated by three free or uninterengaged loops, i.e. at least two uninterengaged loops. This selection of three free loops allows the longitudinal dimension of the net openings **13** to approximate the lateral dimensions which are defined by the spaces between the parallel warp wales. While this produces a symmetrical net, it will be apparent that the spacing between the courses may be otherwise chosen by selecting a different number of uninterengaged loops of warp.

As shown in broken lines in FIG. 3, a second weft end **11'** may be arranged, for example, to precede (as shown) or to follow the first end **11** to pass through the next successive loops. In the resulting fabric, there would be two adjacent courses of weft spaced by two free loops of warp. It will be apparent that other combinations may be devised, for example, two or more weft ends may be symmetrically spaced by warp loops, or more than one weft end could be used to pass through the same loop. In the preferred form of fabric, at least some of the loops should be free from interengaged weft ends.

If desired, the weft ends, instead of being laid through the loops of the warp as shown in FIGS. 1 and 3, may be knitted or stitched (in a knitting sense) to the warp ends as shown in FIG. 4. It will be apparent that this forms a tightly knitted net, but places a restriction upon the maximum size of weft end which can conveniently be used. If desired, one end, for example a thick bulky yarn, might be laid in as shown in FIG. 3, and a separate weft end which might be a thinner thread or yarn, might be stitched in as in FIG. 4. Numerous combinations will be apparent to those skilled in the art.

In a preferred form of fabric, weft ends or at least some of them, are composed of elastic threads or yarns which may be, for example, of cotton covered rubber thread or of spandex type yarn. Such products are suitable; for example, for elastic bandages or supports, braces, girdles, and the like. A particularly useful application is in the wrapping of meat products such as sausages, salami, rolled ham, and joints of meat. For the latter purpose, the construction shown in FIG. 1 is particularly useful, the single weft end being, for example, of cotton covered elastic of food quality, that is, which does not contain ingredients injurious to the food being wrapped. A suitable form of food quality elastic is described, for example, in U.S. Pat. No. 3,178,910, issued on Apr. 20, 1965, to H. Hammerle. The Latter Patent describes a similar form of net for wrapping up meat products utilizing separate weft ends joined at a longitudinal seam. It will be apparent that the present net products in accordance with the invention is an improvement in providing an entirely symmetrical structure free from any seams, which may at the same time be more economically fabricated through use of the machine of the present invention as will become apparent.

THE APPARATUS

An embodiment of apparatus in accordance with the invention is illustrated in FIG. 5 onwards. With particular

reference to FIGS. 5 and 6, there is shown a cylindrical knitting frame or bed **20**, which in the embodiment illustrated is arranged to be stationary. The frame is provided with circumferentially distributed grooves **21** containing vertically reciprocable latch type hooked needles **22** of the conventional type. However, beard needles may be used if desired. The circular knitting frame **20** is of conventional type and will not be described in great detail. It will be apparent from FIG. 6 that not all the grooves **21** on the bed **20** are utilized for the warp needles **22**. For the sake of clarity, FIGS. 5 and 6 are not to strict scale and show one empty groove **21** between two warp needles. In order to produce the fabric, for example, of FIGS. 1 to 3 on a machine bed with standard spacing, every fourth groove may be used to house a warp needle, the remaining grooves being empty, to achieve the desired spacing between the warp wales.

The knitting frame **20** is internally supported by conventional means (not shown) to a machine bed **23**, the frame and bed having a central hole down through which the product passes as it is knit. A rotating support **24** is mounted for rotation with respect to te machine bed **23**, by means of a conventional ball race, not shown, and is connected for rotation by a conventional drive to an electric motor, such rotation resulting in operation of the machine. Rigidly mounted to the rotatable support **24** is a first rotatable cam ring **25** having four circumferentially distributed cams **46** and associated guides **47**. As shown in FIG. 6, the cam and guides **46**, **47** are arranged to engage with outwardly projecting butts or cam followers at the foot of each needle to raise and lower the needles successively as the rotating support **24** rotates.

An upper rotating cam ring **26** is mounted by pillars **27** from the rotating support ring **24** upwardly spaced from the lower cam ring **25** and mounted to the underside of the ring **26** are respective latch stops **28**, which project forwardly in alignment with the upper part of respective cams **46** to obstruct the latches of the latch needles to prevent premature closure, in a conventional manner.

A stationary support plate **29** is supported from the frame **20** in upwardly spaced relation therefrom, and pivotal warp guides **30** are pivotally mounted upon the upper surface of the support plate **29**, one above each warp needle, so as to extend outwardly from the edge of the plate **29**. Each guide **30** is provided with a guide portion, for example in the form of an eye **31**, at its outward end, the eye being capable of a pivoting movement around the pivot elements **32** of the guide in the form of an arc which embraces the axis of the respective needle from one side of the needle to the other. Respective warp ends **33** are each fed from a separate source, not shown, via tensioning means, also not shown, through an eye **31** and downwardly through the hollow interior of the knitting frame **20**. The tension means, for example, may simply consist of adjustable weights hung from the individual warp ends **33** which may be fed directly from bobbins.

Mounted to the uper surface of the upper cam ring **26** in aligned relationship with the cams **46**, are four second cams **34** which may be in the form of bent plates as illustrated, bolted to the top of the upper ring **26** so that they extend downwardly within the inner edge of the ring **26**. The inner surfaces of the cams **34** are adapted to engage the free ends of the pivotable guides **30** substantially centrally of the width of the cams.

The manner of engagement of the cams **34** and the pivotable guides **30** will be appreciated from FIG. 5. The warp ends **33** are fed to the eyes **31** at a partly tangential angle so that they tend to draw the guide elements **30** in a clockwise sense as viewed in FIG. 5 or oppositely to the direction indicated by the arrow, the arrow indicating the direction of rotation of the rotatable cam rings. As a cam **34** comes into successive engagement

with a pivotable guide **30**, it moves the guide from its clockwise-most end position (shown also in hard lines in FIG. 7) to its anticlockwise-most end position (shown in dotted lines in FIG. 7). It will be appreciated that the cams **34** sweep the elements **30** around in overlapping relationship or in the manner of a continuous wave. The elements do not have to be arranged so that there is clearance between the sweeps of one element and the next. As the guide elements **30** slide free of the downstream end of the cams **34**, they automatically pivot back to the clockwise-most position under the tension in the warp ends **33**. It will be apparent that while the tension in the warp ends is utilized in this particular embodiment to return the guide elements, alternative means may be used, such as for example coil springs around the pivot elements **32**. The pivot elements may also comprise or be essentially composed of leaf springs.

Passing centrally up through the support plate **29** is a bar or axle **35** used to support a conventional frame, mounting bobbin holders and guide means for the warp ends **33** (not shown). In the present embodiment, this upper frame is held stationary.

Bolted to the upper cam ring **26** are mounting brackets **36** for a weft bobbin holder **37** holding a bobbin **38** of weft yarn **39**. The bobbin holder **37** is provided with an internal coil spring, not shown, in order to tension suitably the weft yarn **39**. The machine being set up to produce the fabric of FIG. 1, the weft yarn **39** consists only of a single end, and is fed directly through a travelling guide **40** mounted to and extending downwardly from the upper cam ring **26**. Thus, the brackets **36** and travelling guide **40** rotate together with the upper and lower cam rings and the weft yarn is fed from the travelling guide against the rim of the knitting frame **20** so as to pass behind, i.e. interiorly of, and adjacent to the needles as they rise, as will become more fully apparent in the discussion of the operation of the machine. The end may be fed directly from the bobbin through the travelling guide **40** to the needles. However, if the weft end consists of an elastic yarn as illustrated in order to make the elastic net structure of FIG. 1, it is preferred to use a tensioning device, the subject of copending application Ser. No. 614,939, filed on Feb. 9, 1967, to Bernard H. Engelhardt.

It will be apparent to those skilled in the art that the introduction of elastic thread requires carefully controlled tensioning. The dimensions and more particularly the radius of the final net product will depend upon the tension under which the elastic is fed as well as upon the dimension of the knitting frame. Thus, if the elastic is fed under tension and afterwards allowed to relax, the tubular product will shrink lateraly bringing the warp wales close together. Therefore, by suitably controlling and adjusting the tension, tubes of different diameter may be knitted.

In order to provide the controlled tension of feed, the spring of the bobbin holder **37** is adjusted to bring the elastic to full stretch and one or more full turns are wrapped around a tensioning wheel **41**, which is a cylinder of wood or moulded plastics material having spaced flanges **42** bordering a concave outer rim surface. The travelling guide **40** is provided with two eyes **43**, **44** adjacent the rim of wheel **41** and a further eye **45** on a level with the top of the knitting frame **20** so that the weft end **39** passes through the lowermost eyelet **43**, at least once clockwise around the wheel **41**, out through the intermediate eye **44**, back through the upper eye **45**, and into engagement with the needles. In the present embodiment, the wheel **41** is maintained stationary by being mounted directly to the knitting frame **20**. The yarn is continuously wound off the wheel as the guide **40** rotates so that the yarn relaxes on the wheel in operation, being gradually reduced in tension by an amount depending upon the difference in circumference between the rim of the wheel **41** and the circumference of the top of the knitting frame **20** where the weft end **39** is finally laid.

The novel tensioning device allows extremely careful control of the tension in the elastic weft and thereby allows adjustment, by replacing the wheel **41** with another wheel of different diameter, of the diameter of the product. To assist in the ready replacement of the wheel **41**, this may be made in two parts split along a diameter, the parts being clamped together in position around the knitting frame **20**.

It will be apparent that if it is desired to use more than one weft end, the wheel may be enlargetd, if necessary with intermediate flanges, to take two or more weft ends, or a number of wheels **41** may be arranged axially adjacent.

OPERATION OF THE MACHINE

As the drive means rotates, the upper and lower cam rings rotate relatively to the knitting frame **20**; the lower cam elements **46**, **47** cause the needles to lift and lower as the weft yarn **39** is laid behind the rising needles and simultaneously as the pivotable warp guides **30** swing from right to left as viewed in FIG. 5. The details of the knitting operation, which may be attained by suitable adjustment of the cams **34**, is shown most clearly in FIGS. 7*a* and 7*b*. As a cam **34** approaches a warp needle which is in its lowermost rest position, the weft yarn **39** is fed under a reduced tension radially inwardly across the warp yarn so that it lies radially outwardly of the warp yarn but in a position radially inwardly of or behind the axis of the needle **21**. The warp guide **30** and warp end **33** are in the left-hand position indicated in hard lines with the end **39** passing from eye **31** behind the weft end **39** and under it to the loop attached to the needle. As the needle rises under the action of a cam **46** towards its uppermost position, the upper cam **34** moves the warp guide **30** fully over to the right-hand position indicated in dotted lines, so that end **33** follows the path indicated in dotted lines, across the needle under the hook and at the same time over the weft end **39**. The guide **31** will then be in the position indicated in dotted lines. As the needle is lowered by cam element **47**, a loop of the warp end **33** is drawn down into the needle groove over the weft end **39**. As the needle sinks into its groove, the guide **30** slips off the cam **34** and is drawn by the tension in the warp end back to the first position indicated in hard lines, ready for the next stitch. The warp stitch is repeated with the next movement of the cams, but no weft end is introduced to the same needle until a complete revolution has been made.

It will be appreciated that the stitch may alternatively be performed during the return swing of the guide **31** instead of during the forward swing. In this case the more gradual slope of the cam **34** should be arranged at the rear end instead of at the forward end.

If it is desired to produce the stitch shown in FIG. 4 where the weft yarns instead of being laid through the loops are interknitted with the warp yarns, the travelling weft guide **40** is adjusted so that the weft end **39**, instead of passing behind the needle, is laid in front of the needle as shown in FIGS. 8*a*, 8*b*. The effect of this is that instead of merely drawing a loop of warp end into the needle groove, the needle also engages with the weft end and draws the two ends together into the needle groove. This is clearly shown in FIG. 4. In the subsequent knitting motion, the needle merely pulls another loop of the warp end alone through the double loop formed in the previous stitch and subsequently continues merely the warp chain.

When considering FIGS. 3 and 4 in connection with the operation of a knitting needle illustrated by reference to FIGS. 7 and 8, it may be of assistance to note that in these figures the chains are viewed in a direction outwardly from the interior of the knitting frame.

It will be appreciated that the arrangement of the machine with a single weft end and four spaced cams

will produce the fabric shown in FIGS. 1 to 3 in which a weft course is laid in every fourth loop of the warp. This is because each course represents a full revolution of the machine, whereas each cam produces one warp stitch, and there are four cam movements for each revolution. It will be appreciated from this that the number of warp stitches between each course may be increased by increasing the number of cam movements of the warp needle for each revolution, and may be similarly reduced. Alternatively, two separate weft ends may be used by, for example, arranging a second bobbin holder diametrically opposite to the first so that two weft ends were laid simultaneously. If the same number of cams is used, that is, four, this will result in a second course derived from the second end appearing in the loop centrally between those shown in hard lines in FIG. 3. The stitch shown in broken lines in FIG. 3 may be obtained by using a second weft end and laying it in during the cam operation immediately subsequent to that during which the first weft end is laid. It will be apparent that a whole succession of weft bobbins may be arranged circumferentially around the upper cam ring **26**, if desired. Similarly, if it is desired to pass two weft ends through the same loops, two weft bobbins may be mounted on the same bobbin holder, the yarns being passed together through the same eyes.

I claim:

1. A seamless tubular knitted open-mesh fabric comprising parallel spaced apart longitudinal warp wales of substantially non-elastic yarn continuously crochet knitted from separate warp ends, and one or more weft ends of elastic thread each extending in a continuous spiral around the tubular knitted fabric and in interengagement with

loops in each of the warp wales, mesh openings in the fabric, said mesh openings being defined on one pair of opposed sides by groups of at least 2 successive loops in each of a pair of said warp wales which are adjacent, said successive loops being free from interengaged weft ends, and on another pair of opposed sides by said elastic thread of said warp ends.

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WM. CARTER REYNOLDS, Primary Examiner

U.S. Cl. X.R.

66—195

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,513,668 Dated May 26, 1970

Inventor(s) MARCUS MINTZ

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 8, line 7, cancel "warp" and insert ---weft---.

Signed and sealed this 8th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334